Engineering Risk Analysis Group
Prof. Dr Daniel Straub

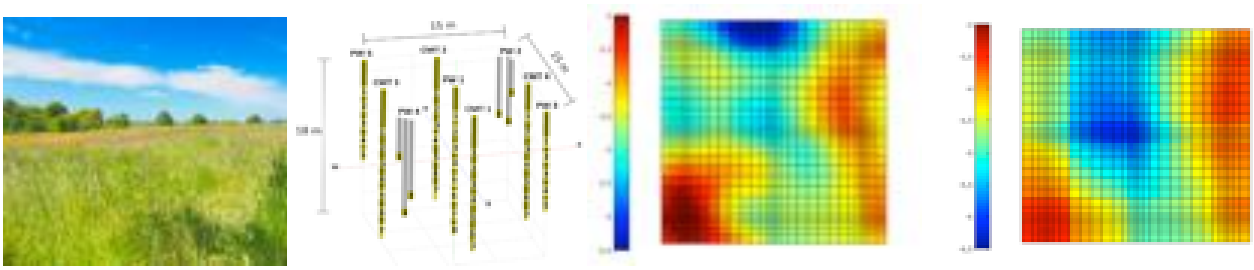
MSc thesis

# Application of FORM to Hydraulic Tomography

Josef Wildgruber, June 2015

## Background

The spread of substances in the subsurface is dependent on groundwater flows. Considering an exposition of contaminants into the ground, an approach that allows to make reasonable predictions on the consequences is desired. Since the methods to measure the fluxes directly are costly, they are in general derived from the ground parameters. These are highly heterogeneous, therefore they have to be estimated based on observations of hydraulic heads.



*Unknown subsurface domain; Instrumentation for hydraulic tomography; simulated parameters; FORM result*

## Methodology

An algorithm to estimate ground parameters by The First Order Reliability Method (FORM) and KL-Expansions was implemented. It is based on a numerical simulation of hydraulic tomography, a technique to gather observations of hydraulic heads from pumping tests. Subsequent, a sensitivity analysis gives the relationship between ground parameters and hydraulic heads. These tools allow to adjust random fields of ground parameters in a way that they match observations of hydraulic heads obtained by hydraulic tomography in a unknown domain.

## Results

The application of the FORM approach to a given domain with simulated values for the ground parameters shows its ability to produce reasonable estimations. Their quality depends on the number of observations taken into account, and the amount of standard normal random variables in the KL-Expansion. A larger number of observations improves the estimation, but increases the probability of having redundant information at the same time. The KL-Expansion can reduce the computational effort while maintaining a high quality.

Supervised by Dr.-Ing. Iason Papaioannou, Prof. Dr. Daniel Straub (TUM),
Dr. Chin Man Mok (GSI Environmental)